

**TITLE OF THE INVENTION**

**METHOD OF AND APPARATUS FOR RECORDING DATA IN VARIOUS RECORDING FORMATS ON AN OPTICAL STORAGE MEDIUM, METHOD OF AND APPARATUS FOR REPRODUCING THE DATA, AND AN OPTICAL STORAGE MEDIUM ON WHICH THE DATA IS RECORDED**

**CROSS-REFERENCE TO RELATED APPLICATION**

**[0001]** This application claims the benefit of Korean Patent Application No. 2002-46174 filed on August 5, 2002 in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

**BACKGROUND OF THE INVENTION**

**1. Field of the Invention**

**[0002]** The present invention relates to a method of and apparatus for recording data on an optical storage medium, a method of and apparatus for reproducing the data, and an optical storage medium on which the data is recorded, and more particularly, to methods of recording data in various recording formats on an optical storage medium and reproducing the data, an optical disc recording/reproducing apparatus used when performing such methods, and an optical storage medium on which the data is recorded.

**2. Description of the Related Art**

**[0003]** Generally, an optical disc recording/reproducing apparatus records/reads data on/from an optical storage medium. There are various types of optical storage media, such as a

CD-ROM, a CD-R/RW, a DVD-ROM, a DVD-RW, and a DVD-RAM. Data can be recorded on or reproduced from these optical storage media using a CD-ROM drive, a CD recorder, a DVD-player, a DVD recorder, and a DVD-RAM drive, respectively.

**[0004]** Meanwhile, video and/or audio data must be recorded on an optical storage medium in a standard recording format prescribed by an international organization. A conventional optical disc recording apparatus records data on an optical storage medium in the same recording format selected according to the type of the optical storage medium. Also, a conventional optical disc reproducing apparatus only reproduces data recorded in the same recording format, determined according to the type of the optical storage medium. For instance, data needs to be recorded in a DVD-video format on a DVD-RW disc and recorded in a DVD-VR format on a DVD-RAM disc. Accordingly, data is recorded in a recording format suitable to the type of an optical storage medium when using the conventional optical disc recording apparatus.

**[0005]** In order to record data in different recording formats, a disc matching the various recording format and a recording circuit matching the disc are required. Also, a reproducing circuit is further required to reproduce the data recorded in a recording format suitable to the type of an optical storage medium.

## **SUMMARY OF THE INVENTION**

**[0006]** The present invention provides methods of recording data in a desired recording format on an optical recording medium regardless of the type of the optical storage medium, and reproducing the data.

**[0007]** The present invention also provides methods of recording data in various recording formats on an optical storage medium, and reproducing the data.

**[0008]** The present invention also provides an optical disc recording/reproducing apparatus used when performing such methods.

**[0009]** The present invention also provides an optical storage medium on which data is recorded using such methods.

**[0010]** Additional aspects and advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

**[0011]** According to an aspect of the present invention, a method of recording data on an optical storage medium in a certain recording format includes selecting a recording format to record the data on the optical storage medium, recording the data on the optical storage medium in the selected recording format, and adding information regarding the selected recording format on the optical storage medium.

**[0012]** According to another aspect of the present invention, a method of reproducing data from an optical storage medium in which data is recorded includes reading recording format

information regarding desired data from an information area of the optical storage medium, and reproducing the desired data based on the recording format information.

**[0013]** According to yet another aspect of the present invention, a method of recording data on an optical storage medium in a plurality of recording formats includes selecting one of the plurality of recording formats for each data to record the data on the optical storage medium, recording the data on the optical storage medium in the selected recording format, and adding information regarding the selected recording format on the optical storage medium whenever each data is recorded in one of the selected recording formats.

**[0014]** According to still another aspect of the present invention, a method of reproducing data from an optical storage medium includes reading a file system from the optical storage medium, reading recording format information and starting address of desired data from the file system, and reading the data from the starting address and decoding the data based on the recording format information.

**[0015]** According to still another aspect of the present invention, an optical disc recording apparatus which records data in a certain recording format includes a codec which is capable of compressing/encoding the input data signal in various recording formats, a digital signal processor (DSP) which receives the data signal from the codec and performs a predetermined modulation on the data signal, an amplifier which amplifies the modulated data signal, a pickup which generates a beam and records data on an optical storage medium in response to the amplified data signal, a servo which performs a servo control on the pickup, and a controller

which receives a recording format selected by a user through a user interface and informs the codec and the DSP of the selected recording format so as to record the data in the selected recording format.

**[0016]** According to still another aspect of the present invention, an optical disc reproducing apparatus which reproduces data from an optical storage medium on which data is recorded in various recording formats includes a pickup which emits a beam on the optical storage medium and outputs a data signal, an amplifier which amplifies the data signal, a DSP which receives the amplified data signal and performs a predetermined demodulation on the data signal, a codec which decompresses/decodes the demodulated data signal in various recording formats, a servo which performs a servo control on the pickup, and a controller which reads recording format information regarding desired data from the optical storage medium and informs the codec and the DSP of the recording format information so as to reproduce the desired data recorded in the recording format.

**[0017]** According to still another aspect of the present invention, an optical storage medium includes data recorded in a recording format in an area and recording format information recorded in an area adjacent the area containing the data.

**[0018]** According to still another aspect of the present invention, an optical storage medium includes data recorded in various recording formats and file system information recorded in a predetermined area, the file system information including information regarding recording formats and starting addresses of the data.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

**[0019]** These and/or other aspects and advantages of the present invention will become more apparent and more readily appreciated from the following description of embodiments thereof, taken in conjunction with the accompanying drawings of which:

FIG. 1 is a block diagram of an optical disc recording/reproducing apparatus according to an embodiment of the present invention;

FIG. 2 is a diagram illustrating a data structure in which data is recorded in various recording formats, according to an embodiment of the present invention;

FIG. 3 is a diagram illustrating a data structure in which data is recorded in various recording formats, according to another embodiment of the present invention;

FIG. 4 is a flowchart illustrating a method of recording data in various recording formats, according to an embodiment of the present invention;

FIG. 5 shows the structure of a directory according to an embodiment of the present invention; and

FIG. 6 is a flowchart illustrating a method of reproducing data recorded in various recording formats, according to an embodiment of the present invention.

## **DETAILED DESCRIPTION OF THE EMBODIMENTS**

**[0020]** Reference will now be made in detail to the embodiments of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference

numerals refer to like elements throughout. The embodiments are described below in order to explain the present invention by referring to the figures.

**[0021]** FIG. 1 shows a block diagram illustrating an optical disc recording/reproducing apparatus according to an embodiment of the present invention. The structure and operations of the optical disc recording/reproducing apparatus of FIG. 1 will now be explained in relation to a write/read mode.

**[0022]** In the write mode, an audio/video (AV) codec 128 receives A/V data from an outside source (not shown), compresses and encodes the AV data in particular units using a particular compressing and encoding system, and provides information (e.g., size and reproduction time) regarding the encoded A/V data. Also, the AV codec 128 according to an aspect of the present invention enables data to be compressed and encoded in various recording formats. Thus, a user can easily compress and encode data in a desired recording format using the AV codec 128. Since an encoder/decoder that encodes/decodes data in various recording formats is well known by one of ordinary skill in the art, additional explanations thereof will be omitted here.

**[0023]** A digital signal processor (DSP) 122 adds data required for an error correction coding (ECC) to the data encoded by the AV codec 128 and modules the obtained data using a particular modulating system.

**[0024]** A radio-frequency (RF) amplifier 116 converts electrical data, which is input from the DSP 122, into an optical signal. A pickup 114, which has a built-in actuator (not shown) having

focusing and tracking functions, records the optical signal, which is converted by the RF amplifier 116, on a disc 112. A servo 118 receives information required for servo control from the DSP 122, using the RF amplifier 116 and a system controller 124.

**[0025]** When a user selects a recording format using a key input unit 126, the system controller 124 informs the AV codec 128 and the DSP 122 of the selected recording format. Then, the AV codec 128 and the DSP 122 encode and modulate input data in the selected recording format. Next, the data in the selected recording format is recorded on the disc 112 through the RF amplifier 116 and the pickup 114. After completion of the recording, information regarding the recording format of the recorded data is recorded on the disc 112.

**[0026]** In the read mode, the pickup 114 reads the optical signal from the disc 112 using a laser beam. The RF amplifier 116 converts the optical signal output from the pickup 114 into an electrical signal and extracts a servo signal for a servo control and modulated data. The DSP 122 demodulates the data modulated by the RF amplifier 116 and performs an ECC to correct an error contained in the data. The servo 118 receives control information for a servo control from the RF amplifier 116 and the system controller 124, and stably performs the servo control. The AV codec 128 decodes the AV data that is compressed and encoded by the DSP 122.

**[0027]** When a user inputs a command to the system controller 124 using the key input unit 126, the system controller 124 controls the pickup 114, the RF amplifier 116, the DSP 122, and AV codec 128 to reproduce the AV data recorded on the disc 112. During the reproduction of the AV data, the system controller 124 reads a file system of the disc 112 when the disc 112 is



determined to be a finalized disc, moves the pickup 114 to the position of a file and reads data contained in the file and information regarding the recording format of the data when a user selects the file. The system controller 124 controls the DSP 122 and the AV codec 128 to reproduce the data recorded in the recording format. While shown as an apparatus that records and reproduces data, it is understood that the apparatus can be only for recording data or only for reproducing data.

**[0028]** FIG. 2 shows a diagram illustrating a data structure of an optical storage medium in which data is recorded in various recording formats, according to an embodiment of the present invention. Referring to FIG. 2, AV data is recorded on an optical storage medium, for example, a DVD-RW or a DVD-RAM, in various recording formats. That is, as shown in the example in FIG. 2, DVD data, MP3 data, video CD (VCD) data, MPEG4 data, DVD data, MPEG4 data, video recording (VR) data, MP3 data, and VR data can be sequentially recorded on the optical storage medium.

**[0029]** To reproduce data recorded on the optical storage medium in various recording formats, information regarding the various recording formats is required. For this reason, information regarding a recording format must be recorded when recording data on an optical storage medium. There is no limit to an area of the optical storage medium in which the recording format information is recorded.

**[0030]** In the embodiment of FIG. 2, an information area I containing recording format information is formed an area right before each data area D in which data is recorded in a

selected format. In the information area I, information regarding attributes of data, such as the size of data and a starting address, may be recorded in addition to the recording format information.

**[0031]** Each recording format information may be recorded in an area right before or after each data area D. Otherwise, according to another aspect, all recording format information may be recorded together in another area of an optical storage medium, such as a lead-in or lead-out area.

**[0032]** As shown in FIG. 3, the recording format information regarding respective data, as well as information regarding the positions of respective data, can be recorded in a certain area of a recording area of an optical storage medium. For instance, information (e.g., title, starting address, and recording format) regarding each data is recorded in a table format in the certain area. A file system can be stored in an information area I of FIG. 3.

**[0033]** The file system includes respective directories for respective recording formats, and each directory includes information (e.g., title, starting address, recording format type, and data size) regarding data in a particular recording format. If such a file system is prepared and recorded on an optical storage medium, a user can not only obtain information regarding respective data, but also readily select and reproduce desired data from the optical storage medium based on the information.

**[0034]** It is preferable, but not required, that the file system is recorded after completion of all data recording on an optical storage medium. However, for a rewritable disc such as a DVD-RW disc or DVD-RAM, a file system can be prepared every time data is recorded. Although it is preferable that a file system is recorded on a write once disc (e.g., a DVD-R disc) after recording of data on the entire disc, it is possible to prepare a file system every time when data is recorded. Further, it is possible to form respective information areas, which contains respective recording format information, right before respective data areas of an optical storage medium as shown in FIG. 2, and prepare a file system in only a predetermined area of recording areas of the optical storage medium as shown in FIG. 3.

**[0035]** The system controller 124 of the optical disc reproducing apparatus according to an aspect of the present invention reads recording format information recorded in the information area I and appropriately reproduces data recorded on a data area D based on the recording format information.

**[0036]** FIG. 4 shows a flowchart illustrating a method of recording data in various recording formats on an optical storage medium, according to an embodiment of the present invention. Referring to FIG. 4, when an optical storage medium is inserted into a recording apparatus, the presence of the optical storage medium is checked using a disc detection sensor (operation 410). After the optical storage medium is detected, lead-in information is read from the optical storage medium to check the type of the optical storage medium, for example, whether the optical storage medium is a DVD-RW, a DVD-RAM, or the like (in operation 420).

**[0037]** In operation 422, it is checked whether a file system is present so as to determine whether the optical storage medium is finalized. The finalization of a optical storage medium refers to a process in which a title and information regarding the title are recorded on the optical storage medium. If the finalization of the optical storage medium is confirmed, a recording operation on the optical storage medium is completed.

**[0038]** In operation 430, a desired recording format is selected using a user interface. In operation 430, the user may select from multiple recording formats, such as MPEG2, MPEG4, MP3, audio compression 3 (AC3), and linear pulse code modulation (LPCM). In operation 440, AV data is compressed/encoded and recorded in a data area D of the optical storage medium in the selected recording format.

**[0039]** In operation 442, it is checked whether a recording of the title or data in the selected recording format is completed. If it is determined in operation 442 that the recording operation is completed, information regarding the recording format and the attributes of the recorded data is recorded in an information area I of the disc (in operation 450). The information area I is positioned, for example, right before or after an area where the data is recorded.

**[0040]** In operation 452, it is checked whether a user desires to further record data on the optical storage medium using the user interface. To further record the data, a desired recording format is selected, which may be a different format than previously selected, and operations 440 through 450 are repeated.

**[0041]** If the user desires to record data in various recording formats, the data can be recorded in various recording formats, such as DVD, MP3, VCD, MPEG4, DVD, MPEG4, VR, MP3, and VR, on the optical storage medium as shown in FIG. 2.

**[0042]** Where the recording operation is terminated, it is checked whether the user desires to prepare a file system using a command input to a system controller 124 using a user interface (in operation 460). If it is determined in operation 460 that the command is input to the system controller 124, the system controller 124 performs finalization of the optical storage medium so as to prepare the file system in operation 470. During the finalization of the optical storage medium, the file system is prepared using the information regarding data recorded on the optical storage medium. The file system is used to detect, for example, the title of the data in a certain recording format.

**[0043]** For instance, when data is recorded on the optical storage medium in various recording formats as shown in FIG. 2, the system controller 124 makes directories corresponding to the recording formats for a DVD, a VCD, an MP3, an MPEG4, and a VR. As shown in FIG. 5, directories corresponding to the recording formats for an MP3, a VCD, an MPEG4, and a VR, are further added to a directory related to the DVD format of an existing DVD. The respective main directories include sub directories for the titles of the respective recording formats.

**[0044]** When new data is recorded on the optical storage medium in a recording format, the title of the new data is added to the directory in the recording format. When new data is recorded on the optical storage medium in a new recording format, a directory for the new recording

format is prepared. In this way, the existing directories can be updated and a new directory can be added when new data is recorded on the optical storage medium.

**[0045]** Also, a file system may be recorded on a predetermined area of the optical storage medium before the recording of the data.

**[0046]** FIG. 6 shows a flowchart illustrating a method of reproducing data recorded in various recording formats, according to an embodiment of the present invention. Referring to FIG. 6, the presence of an optical storage medium is first checked using a disc detecting sensor whether the optical storage medium is inserted into a reproducing apparatus (in operation 610). In operation 620, after the presence of the optical storage medium is confirmed, the type of the optical storage medium is checked. For example, it is checked whether the optical storage medium corresponds to a DVD-RW, a DVD-RAM, or the like.

**[0047]** In operation 630, the presence of a file system is checked to determine whether the optical storage medium is finalized. If the optical storage medium is yet to be finalized, data recorded on an information area I of the optical storage medium is read (in operation 650). If the optical storage medium is finalized, the file system is read and a root directory is analyzed (in operation 640).

**[0048]** Thereafter, in operation 660, information regarding formats recorded the information area or the file system is read, and desired data is decoded and output based on the read

information. Where a command of completing data reproduction is input, the reproduction of the data is completed (in operation 670).

**[0049]** While the present invention has been particularly described with reference to a CD or DVD, it is understood that the present invention can be applied to other storage media. For instance, the present invention can be applied to a high-density recording medium, such as HD-DVD, Blu-ray Discs, Advanced Optical Discs, as well as recording media such as the CD and the DVD.

**[0050]** Further, it is understood that the methods of FIGs. 4 and 6 can be implemented using software (including firmware) encoded on a computer readable medium usable with either a special purpose or a general purpose computer.

**[0051]** As described above, data can be recorded on an optical storage medium, such as a CD-R/W, a DVD-R/W, or a DVD-RAM, in recording formats selected by a user regardless of the optical storage medium. Also, the user can easily record the data in a desired recording format regardless of the type of recording medium.

**[0052]** Although a few embodiments of the present invention have been shown and described, it will be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the principles and spirit of the invention, the scope of which is defined in the accompanying claims and their equivalents.